Training Students' Critical Thinking Skills Through Implementation of Problem Solving Models On Reaction Rate Materials

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Abstract- Critical thinking skills are one of the high-order thinking skills that students need for survival living in the 21st century. Critical thinking skills are needed to solve various problems by questioning what they hear and reviewing certain thoughts. The aim of this research is to describe learning activity and students' critical thinking skills through implementation of problem solving models on reaction rate materials. This research used a Pre-Experimental with one-group pretest-posttest design. The subjects were 70 students from the two classes of XI MIPA. The instruments that was used included observation sheet for learning activity with implementation of problem solving models and test sheets of the critical thinking skills. The results showed that: 1) learning activity with the implementation of problem solving model got good category, 2) critical thinking skills after implementation of problem solving model have reached skilled and highly skilled category that was proven by the average score of students at XI MIPA 3 is 80.83 and XI MIPA 4 is 83.10.

Index Terms- Critical thinking skills, problem solving model, reaction rate material

I. Introduction

The development of Science and Technology in the current era requires people to be able to compete through improving their quality so that they can keep up with the demands of the 21st century. Self quality improvement is related to improving the quality of education. Education is designedfor students to be able to solve all the problems by mastering knowledge and skills. Multidimensional problems are likely to arise, so it requires a large number of skilled people who can contribute significantly to provide solutions [1].

Problems cannot be solved without thinking. The meaning of this statement is students need to manage their knowledge in designing the solution. Knowledge acquisition needed by someone to be able to solve problems, so learning is more meaningful [2]. Creative problem solving needs students' critical thinking skills, such as the skills to analyze, evaluate, explain, and make decisions [3].

Critical thinking skills are processes that emphasize a logical and rational basis of trust, and provide a set of standards and procedures for analyzing, testing, and evaluating [4]. There are six main critical thinking skills according to Facione who are involved in critical thinking processes, including: interpretation, analysis, evaluation, inference, explanation, and self-regulation [4].Therefore, critical thinking skills needto be trained in learning activities, especially in science. A learner must accept the existing truth, recognize science as a product and also as a process, a way to prove the truth that explores new scientific knowledge [1]. However, students' critical thinking skills are still low. The statement was supported by research from Rasmawan that the students' critical thinking skills are low with unskilled category has reached 81,25% [5]. The other research also found that the average of students' critical thinking skills is 51.60% in the low category [6]. Besides, the research conducted by Saputra, Hidayat, and Munzil showed that student's critical thinking skills are still low [7]. These results indicate that students are not accustomed to training critical thinking skills in learning.

Critical thinking skills are also needed in Chemistry learning. One chemical topic that requires critical thinking skills is the reaction rate. The reaction rate material has several characteristics, namely: concepts are abstract, mathematical counts, graphs, and involves multiple representations (macroscopic, microscopic, and symbolic [8]. The learning is often done only on the macroscopic and symbolic. In addition, the reaction rate material requires hands-on learning experience through experiments, so students must be able to identify, analyze, evaluate and conclude. Therefore, it takes a critical thinking skill in understanding the material of the reaction rate comprehensively, so that students can solve a problem with the right solution.

One of the strategies to train students' critical thinking skills is by holding variations in learning through the selection of appropriate models, namely problem solving models. The problem solving model is a model in which there are activities of critical thinking skills that begin with confrontation and end with solutions according to the conditions of the problem [9].

In line with the research of Sulistyaningkarti, Budi, and Haryono that problem solving models equipped with worksheet can improve critical thinking skills and student learning achievement seen from 77% in the first cycle to 90% in second cycle [10]. The research conducted by Laila and Azizah also shows that problem solving models can train the skills of planning and evaluating at 80.21 and 79.82 [11]. Problem solving instruction is effective to understanding material, problem solving skills, and using strategies [12]. The facts prove that problem solving models can train critical thinking skills.Based on description above, so the aim of this research is to know students' critical thinking skills through implementation of problem solving models.

II. RESEARCH METHOD

This research used a Pre Experimental with One group pretest-posttest design. Subject were 70 students from two classes XI MIPA.The design can be described as follows [13]:

$$O_1 \ X \ O_2$$

2.1 Analysis of learning activity

The instrument that was used included observation sheets of implementation of problem solving models. Activities of teacher were observed by two observers were sought the mode. Observation of the implementation of the problem solving model was assessed by observers using a score of 0-3. Score 0 if it is not implemented, score 1 if the activities carried out are not good, score 2 if the activities carried out are good enough, and score 3 if the activities are carried out are good.

2.2 Analysis of critical thinking skills

Tests of critical thinking skills were carried out 2 times, namely pre-test (before being treated with problem solving models) and post-test (after being treated with a problem solving model). The instrument used is a test sheet of students' critical thinking skills. Question in the form of essay consists of 12 questions in which it contains phenomena. Then, students were asked to interpret, analyze, explain, infer, and evaluate. The problem solving model belongs to Polya, which has 4 steps, namely (1) understood the problem, (2) a plan device, (3) carry out the plan, (4) look back [9].

Assessment scores used to assess students' critical thinking skills were 1-4. To determine the score, the rubric was employed to assess students' critical thinking skills. The first step is taken o analyze the critical thinking skills test is to calculate the score using the following formula:

$$\text{Critical thinking skills score} = \frac{\sum \text{score obtained}}{\sum \text{maximum score}} x100$$

Then, the scores of students' critical thinking skills is converted into some category will be presented in Table I. Score of critical thinking skills was obtained during posttest have reached the category of skilled and highly skilled.

Tabel I**:** Critical Thinking Skills Category

Score	**Category**
3.0 – 4.0	Very Skilled
2.1 – 3.0	Skilled
1.1 – 2.0	Rather Skilled
0.0 – 1.0	Unskilled

Students' critical thinking skills before and after using problem solving model were analyzed by calculating the difference in average post-test scores and pre-test (n-gain score). Formulation of N-gain according to Hake is:

$$(g) = \frac{posttest\ score - pretest\ score}{max\ score - pretest\ score}$$

Furthermore, the N-gain criteria was used to determine the category of critical thinking skills described as: (1)learning outcome with "high gain" if (g) ≥0,7; (2) learning outcome with "medium gain" if 0,3≤(g)<0,7; and (3) the learning outcome with "low gain" if (g)<0,3 [14].

III. RESULTS

3.1 Learning activity with problem solving models

Observation of the implementation of the problem solving model was carried out for four meetings. The first meeting on the concentration factors affected the reaction rate, the second meeting on the surface area and temperature factors affected the reaction rate, the third meeting on the catalyst factors affected the rate of reaction, and the fourth meeting on the orde of reaction. The results of observation of the implementation of the problem solving model are shown in Table II and Table III.

Table II: Observation of the implementation of the problem solving model on XI MIPA 3

Aspects	Meeting I	Meeting II	Meeting III	Meeting IV
1) Pre	G	G	G	G
2) Phase 1	GE– G	G	G	GE
3) Phase 2	GE	GE – G	G	GE - G
4) Phase 3	GE - G	G	G	GE
5) Phase 4	G	G	G	GE - G
6) Final	G	G	G	G

Pre = Preliminary activities , Final= Final activity, G = Good, GE = Good Enough

Note:
Phase 1= understood the problem
Phase 2= a plan device
Phase 3= carry out the plan
Phase 4= look back

According to Table II, the preliminary activities and final activities got good category. This shows that the management of learning in the preliminary and final activities has been good, coherent, and complete. In the main activities consisted of 4 phases, the observation score is 2 and 3 with good enough until good category. Overall, the increase occurred in first until the third meeting. This is because students have been trained critical thinking skills using problem solving models. But at the fourth meeting, the decrease occurred because the material taught had different characteristics from the previous meeting.

Table III: Observation of the implementation of the problem solving model on XI MIPA 4

Aspects	Meeting I	Meeting II	Meeting III	Meeting IV
1) Pre	G	G	G	G
2) Phase 1	GE – G	GE - G	G	GE– G
3) Phase 2	GE - G	G	G	G
4) Phase 3	GE - G	G	G	GE – G
5) Phase 4	GE - G	G	GE – G	GE – G
6) Final	G	G	G	G

Pre = Preliminary activity , Final= Final activity, G = Good, GE = Good Enough

Note:
Phase 1= understood the problem
Phase 2= a plan device
Phase 3= carry out the plan
Phase 4= look back

The result of observation in class XI MIPA 4 are almost as same as XI MIPA 3. The preliminary activities and final activities got good category. In the main activities consisted of 4 phases, the observation score is 2 and 3 with good enough until good category. Thus, it can be concluded that the learning activity with problem-solving models conducted by teachers is good.

3.2 Critical thinking skills

Critical thinking skills are needed in learning activities, especially chemistry subjects [15]. The material used in this research is the reaction rate. The concept of reaction rate material studied in this research wasthe factorsthat influence reaction rate and orde of reaction [16].

Tests of critical thinking skills were carried out before and after treatment using problem solving models. The score of critical thinking skills of students in class of XI MIPA 3 at the pre-test was in the range of 0.00 - 39.58 (unskilled - rather skilled). Pre-test scores show that students are not familiar with the questions that require critical thinking skills. After getting the pre-test score, then students are trained in critical thinking skills with a problem solving model using worksheets. In contrast to the results of the post-test score, the scores obtained was in the range of 56.25 - 95.83 (skilled - very skilled). The average score of critical thinking skills is 80.83.

A total of 14 students who scored critical thinking skills at the pre-test were in the rather skilled category and the other got the unskilled category. At the post-test, 26 students got scores that were in the high skilled category and the other got the skilled category.

In class XI MIPA 4, the pre-test score of critical thinking skills obtained by students was 0.00 - 39.58. The score is in the category of unskilled to rather skilled. Then, students were trained using a problem solving model and given a test at the end of learning. The score obtained at post-test was 68.75 - 95.83 (skilled - very skilled) and the average score is 83.10.

At the time of the pre-test, as many as 10 students who got the score of critical thinking skills were rather skilled and the other belong to unskilled category. In contrast, 27 students' score of critical thinking skills gained after the post-test were found in the high skilled category, while most of the other studentsother got skilled category.

Nonetheless, after the post-test was conducted, there are few students who got low score. This is because they feel confused with the orde of reaction. This material has little connection with everyday life and has different characteristics from the factors that influence the reaction rate material.Students always assume the function of objects is the same, even though problem solving requires to see things in new ways [17]. The description of the pre-test and post-test scores of students' critical thinking skills will be illustrated in Figure 1.

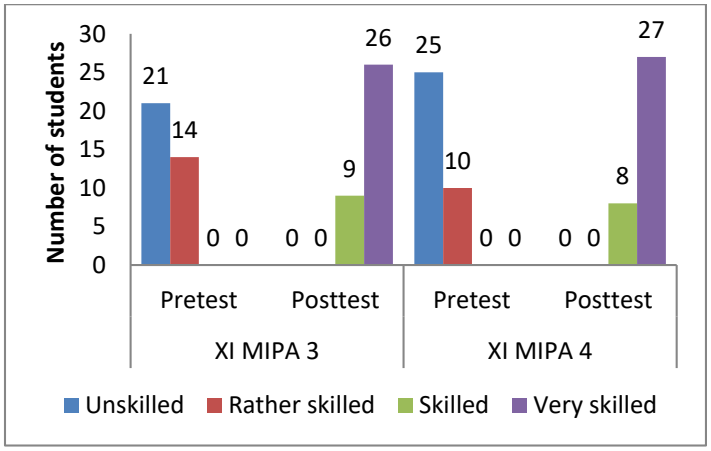

Figure 1: Graph of the number of students with acquisition of critical thinking skills category

Based on the analysis above, it can be seen that there are differences in the scores of critical thinking skills at the pre-test and post-test. A significant increase after the implementation of a problem solving model occured.Students were practiced with worksheets, starting from interpreting problems until evaluating questions. Evaluation part contained questions of the same type and applications in everyday life. Students were initially given a scaffolding to be able to identify problems until they were able toanalyze correctly. Both classes showed good results that critical thinking skills can be trained with problem solving models. Critical thinking skills will increase if you continue to be trained and guided [15].

The difference between pre-test and post-test scores can be used to determine the improvement of students' critical thinking skills after the implementation of problem solving models. In class XI MIPA 3, as many as 25 students received N-gain scores with high criteria, and 10 students got scores with medium criteria. The average N-gain score is 0.75 (high). In class XI MIPA 4 there were 30 students who received high N-gain scores and 5 students got N-gain scores with medium criteria. The average obtained is 0.78 (high). The N-gain score of the two classes is not significantly different.

The results of the calculation on N-gain score of both classes indicate that problem solving models are effective to train students' critical thinking skills. The findings are also in accordance with the results of previousresearchthat students' critical thinking skills with the treatment of problem solving models with video are significantly higher than other learning treatment[18].Critical thinking of students in problem solving increases significantly after students are givencertain problematicsituations [3]. Problem solving learning greatly outperforms traditional learning, where this model can influence knowledge, thinking, and problem solving skills [19].

IV. CONCLUSION

Based on result of research, it can be conclude that: 1) the learning activity with problem solving models got good category, and 2) critical thinking skills can be trained through the implementation of a problem solving model proven by the scores of critical thinking skills of students in class XI MIPA 3 and XI MIPA 4 in skilled and very skilled category.

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